Auto$mart Program

The Auto$mart Guide

How to buy, drive, maintain
your car and save money, energy
and the environment

Natural Resources Canada
Ressources naturelles Canada

Canada

THE AUTO$MART GUIDE

How to buy, drive, maintain your car
and save money, energy and the environment

ISBN 0-662-40242-1
Cat. No. M144-78/2005E

What's in this Guide for You?

The Auto$mart Guide can help you save money. By providing information on how to purchase, drive and maintain your vehicle with fuel efficiency in mind, the *Guide* can lead you to fuel savings, reduced maintenance costs and a longer lasting vehicle. At the same time, you will be contributing to a cleaner, healthier environment and playing an important role in addressing the challenges of climate change.

Here's what's inside:

- An explanation of how your vehicle affects the environment and why it's important for you to join millions of other Canadian motorists in taking action on climate change.
- Useful tips on how to shop for, drive and maintain your vehicle to minimize fuel consumption and costs.
- Information on alternative fuels that can save you money and help the environment.
- A glossary of automotive terms.

Each section of the *Guide* opens with a "Quick Read" page that summarizes key information you need to know to be an Auto$mart driver. However, we recommend you take the time to read the entire *Guide*. Vehicle technology is constantly changing, and even experienced drivers can learn new techniques. And we believe all motorists will welcome the extra money in their pockets from being Auto$mart.

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INTRODUCTION

Canadians have built a society that is the envy of the world. But in the process, we've developed a serious problem. Per capita, Canada uses more energy each year than almost any other country in the world. One of the reasons for that is our love affair with the automobile. Canadians own about 17 million cars, vans and light-duty trucks, and typically drive them more than 290 *billion* kilometres (km) per year.

To a degree, our energy-guzzling ways can be explained by our harsh climate and the vast size of the country. But only to a degree. Research has shown that a great deal of the energy we use is wasted. In the case of vehicles, it's waste caused by inappropriate purchase decisions, inefficient driving habits, unnecessary driving and poor maintenance.

With close to one vehicle for every two Canadians, we have one of the highest ratios of car ownership in the world.

And it's not just a waste of energy – it's a huge waste of money, too. Your money! By some estimates, Canadian motorists could save hundreds of dollars per year in fuel and maintenance costs by paying more attention to fuel efficiency.

There's another compelling argument for fuel efficiency – the need to reduce exhaust emissions that are contributing to environmental and health problems such as climate change, urban smog and acid rain. All Canadian motorists contribute to these problems, and that means we're all part of the solution.

Learn to Drive the Auto$mart Way

That's why Natural Resources Canada has developed **The Auto$mart Guide** *– to help Canadians buy, drive and maintain their vehicles in ways that will conserve energy, preserve the environment, protect our health and save money. You might say it's a win-win proposition for yourself, your fellow Canadians and planet Earth.*

It only makes sense to conserve energy. The gasoline that powers your car is a non-renewable resource, and sooner or later supplies will run out. Yet even as oil supplies dwindle, the number of vehicles on Canadian roads, and the distances they are travelling, continue to grow.

Canada's demand for transportation energy is expected to increase by 40 percent over the next 25 years, and that means we need to find ways to cut our fuel consumption now.

Driving the Auto$mart way is a big part of the answer. It basically means making a personal commitment to fuel efficiency when you buy, drive and maintain your car. These don't have to be painful decisions – in fact, as we've already noted, they should save you money.

Make the Auto$mart Commitment Today

How can you do your part? Use the information in this Guide to become an Auto$mart driver. You'll save energy and money and help protect the environment for future generations. Don't forget to tell your family, friends, neighbours and co-workers about driving the Auto$mart way. We can all make a difference!

For more information and tools to support fuel efficiency on the road, including the EnerGuide label for vehicles, a copy of the most recent *Fuel Consumption Guide*, the *Car Economy Calculator*, a list of the most fuel-efficient vehicles for sale in Canada, or a list of driver trainers who teach Auto$mart techniques, call 1 800 387-2000 or visit our Web site at **vehicles.gc.ca**.

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Section 2

Your Vehicle and the Environment

1. Human activities – primarily those that involve burning fossil fuels – are overloading the atmosphere with greenhouse gases. As these gases accumulate, they are causing temperatures around the world to rise faster than ever before.

2. Climate change could have serious consequences for our environment, our health, our economy and our children's future. It could cause flooding and erosion in coastal regions, major crop and property damage, degradation of our forests and water resources, and increased health problems related to heat and respiratory illness.

3. The principal greenhouse gas is carbon dioxide (CO_2), and cars are a big part of the problem. The average car produces about 2.4 kilograms of CO_2 for every litre of gasoline used. Each year, light-duty vehicles account for roughly 12 percent of CO_2 emissions in Canada.

4. Emissions from transportation sources are growing faster than emissions from any other sector. By 2015, there will be more than 19 million vehicles on Canadian roads.

5. As a party to the Kyoto Protocol, Canada has made an international commitment to reduce its greenhouse gas emissions to six percent below 1990 levels by between 2008 and 2012. All Canadians – including private vehicle owners – need to be part of this national effort.

6. Governments at all levels are working together to help Canadians reduce their greenhouse gas emissions. Natural Resources Canada's Office of Energy Efficiency (OEE) offers numerous programs to encourage Canadian consumers, businesses, industries and institutions to become more energy-efficient on the road, at home and at work. More information is available at the OEE's Web site at **http://oee.nrcan.gc.ca**.

7. Automakers are also doing their part by developing more fuel-efficient vehicles. The focus is on more efficient engine designs, lightweight materials, alternative fuels, hybrid electric vehicles and fuel cells.

QUICK READ

QUICK READ

8. Technology improvements alone will not be sufficient to meet our Kyoto target. Canadians need to buy, drive and maintain their vehicles the Auto$mart way to help bring emissions under control.
9. Fossil fuels are also the main source of chemicals that cause urban smog and acid rain, which are taking a serious toll on our health and our environment. Being an Auto$mart driver will reduce exhaust emissions that contribute to these problems.
10. Auto$mart drivers help the environment, protect our health and save money. It's a win-win proposition.

Canadians are addicted to the automobile – and that's bad news for our environment and our health. Exhaust emissions from personal vehicles are one of the leading causes of climate change, urban smog and acid rain. The good news is we can do something about it by being Auto$mart.

Climate Change

Earth's natural climate is constantly changing – but the current rate and magnitude of climate change is cause for concern. Here are some things you should know about climate change.

Earth's atmosphere is a complex mixture of gases that act like an insulating blanket, trapping some of the sun's heat near the planet's surface, similar to the way the glass of a greenhouse traps the sun's energy. Just as a greenhouse provides the warmth plants need to grow, so does the "greenhouse effect" keep our planet warm. In fact, without these greenhouse gases, the sun's heat would escape, and the average temperature of Earth would drop from 15°C to –18°C (59°F to 0°F) – too cold to support life as we know it.

The greenhouse effect is natural and it's important. But here's the problem: human activities – primarily those that involve burning fossil fuels – are overloading the atmosphere with greenhouse gases. As these gases accumulate, they are upsetting the natural balance that for thousands of years has kept temperatures at just the right level for humans, plants and animals to survive. The growing concentration of greenhouse gases in our atmosphere is causing temperatures around the world to

rise faster than ever before. In Canada, scientists say this could mean an increase in annual mean temperatures in some regions of between 5 and 10°C (9 and 18°F) over the next 100 years. We're already seeing the beginning of this trend: meteorological records tell us that the 1980s and 1990s were the warmest decades on record.

Global warming over the next century could be as great as the change in temperature between the peak of the last ice age, some 25,000 years ago, and today.

So what's the problem with warmer temperatures, especially in Canada? In fact, climate change could have serious impacts on our environment, our economy, our health and our way of life. Consider this:

- Climate change could cause sea levels to rise, causing flooding and erosion in Canada's coastal regions and putting buildings, roads and sewage systems at risk. At the same time, water levels in the Great Lakes and St. Lawrence River are expected to decline.
- Computer models also tell us we could expect more severe weather events such as droughts, floods, hurricanes and winter storms, causing major crop and property damage.
- Canada's forests and water supply could be at risk. A warmer climate would allow pests and diseases to migrate north and add stress to our forests. These forests would also become drier and more likely to catch fire. In some parts of Canada, climate change could lead to a decline in water supply and quality.
- There are important health implications to climate change, including problems related to heat stress, increased air pollution, respiratory illness and allergies.
- If our climate changes too quickly, many plant and animal species may not have time to adjust.

If left unchecked, climate change could have serious consequences for our environment, our health, our economy and our children's future.

There are several greenhouse gases, but the biggest problem is carbon dioxide (CO_2).[1] CO_2 is an unavoidable by-product of burning fossil fuels such as oil, coal and natural gas. And as we've already noted, cars are a big part of the problem.

It's a simple fact: as a motorist, the more fuel you burn, the more CO_2 you produce. The average car produces about 2.4 kilograms of CO_2 for every litre of gasoline used. Each year, light-duty vehicles account for roughly 12 percent of CO_2 emissions in Canada.

The average car produces about three times its weight in CO_2 every year. Cars that are poorly driven and inadequately maintained produce even more CO_2.

As a party to the Kyoto Protocol, Canada has made an international commitment to reduce its greenhouse gas emissions to six percent below 1990 levels by between 2008 and 2012.[2] In reality, because our economy and population are growing, we will actually need to reduce emissions by 25 percent from "business as usual" projections. All Canadians – including private vehicle owners – need to be part of this national effort.

Governments at all levels are working together to help Canadians reduce their greenhouse gas emissions. The federal government's Office of Energy Efficiency, for example, delivers 7 programs to encourage government departments, Canadian consumers, businesses, industries and institutions to become more energy efficient.[3] In the transportation sector these include the

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1 The other principal greenhouse gases are methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and water vapour. Carbon dioxide, methane and nitrous oxide are of primary concern because they are closely associated with human activities.

2 The Kyoto Protocol is an international agreement committing the world's industrialized nations to bring greenhouse gas emissions under control. It was negotiated in Kyoto, Japan, in December 1997.

3 For more information on the Office of Energy Efficiency and its programs, visit its Web site at **http://oee.nrcan.gc.ca**.

Auto$mart Program (which produces this *Guide* and other information materials), EnerGuide for Vehicles (see page 21) and a program to encourage automobile manufacturers to produce vehicles that meet voluntary fuel consumption targets. Natural Resources Canada also supports research and development into alternative transportation fuels and technologies.

Automobile manufacturers are also doing their part. Automakers have taken steps to improve their engines, transmissions and emissions equipment and to make vehicles more lightweight and aerodynamic. As a result, today's vehicles are much more fuel efficient and less polluting than those of 25 years ago. Manufacturers continue to develop advanced automotive technologies, focusing particularly on fuel-efficient engine designs, lightweight materials, alternative fuels, hybrid electric vehicles and fuel cells (see page 55), all of which contribute to Canada's climate change efforts.

However, technological improvements alone will not be sufficient to meet our Kyoto target. That's because Canadians own more vehicles than ever before, and we're driving them further and more often. Even though cars are more fuel-efficient today, have better emission-control devices and must comply with stricter pollution standards, emissions levels are rising. Canadians need to drive the Auto$mart way to help bring emissions under control.

Emissions from transportation sources are growing faster than emissions from any other sector. By 2015, there will be more than 19 million vehicles on Canadian roads.

Air Pollution – Smog and Acid Rain

The burning of fossil fuels is the main source of chemicals that cause air pollution, including nitrogen oxide, carbon monoxide, sulphur dioxide, particulate matter and volatile organic compounds.

Smog – the yellow-brown haze that covers many cities on calm summer days – is the most visible form of air pollution and is of particular concern in urban areas during spring and summer. Ground-level ozone, the major component of smog, is formed when volatile organic compounds and nitrogen oxide react in the presence of warm temperatures and sunlight. Particulate matter is also a key element of smog.

Other Pollutants from Your Car

- Benzene is a carcinogen and one of the volatile organic compounds released as an evaporative emission (rather than an exhaust emission), particularly during refuelling.
- Aldehydes are also carcinogenic. They are caused by incomplete fuel combustion and are released in tailpipe emissions.
- Polycyclic aromatic hydrocarbons are highly toxic compounds, thought to be carcinogenic and produced mainly by diesel exhaust.
- Lead was used for many years as an octane enhancer to prevent gasoline from igniting before it should. Lead levels in the air have almost disappeared since lead was phased out of gasoline in 1990.

Acid rain is caused by pollutants such as sulphur dioxide and nitrogen oxide, which are converted in the atmosphere to sulphuric acid and nitric acid. Diluted forms of these acids fall to Earth as rain, hail, drizzle, freezing rain or snow, or are deposited as acid gas or dust.

Air pollution has serious effects on human health, particularly for people with respiratory problems (such as asthma and bronchitis), children and the elderly. Even healthy people who exercise vigorously outdoors in urban areas are vulnerable.

Thousands of Canadians die prematurely each year from the effects of air pollution, which also increases emergency room visits and hospital admissions. The benefits of reducing smog in Canada's major cities is estimated to be at least $10 billion annually.[4]

Some scientists have predicted that more hot weather due to climate change could mean more frequent and severe smog episodes.

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4 Environment Canada. For more information, visit Environment Canada's Web site, "The Green Lane™," at **www.ec.gc.ca**.

Air pollution is also taking a huge toll on the environment. Acid rain poisons lakes and rivers and damages vegetation, buildings, bridges and roads. Changes in soil chemistry caused by acid rain may be responsible for slower growth rates and increased death rates for trees in certain forest ecosystems. Scientists estimate that more than 300,000 lakes are vulnerable to acid rain, and more than 14,000 are already acidified, supporting only primitive life forms.[5]

Federal and provincial regulations have resulted in the introduction of cleaner gasoline and catalytic converters to reduce vehicle exhaust emissions. New U.S. emissions standards for passenger cars and light-duty trucks will be phased in from 2004 to 2009. These standards are designed to ensure that vehicles run more cleanly by reducing allowable levels of oxides of nitrogen – gases that affect air quality. Canada usually harmonizes its emissions standards with those of the United States.

In addition, Canada has already implemented regulations to lower the allowable level of sulphur in gasoline sold in Canada. These regulations were introduced in 2002 and come into full effect in 2005. Decreasing the level of sulphur in gasoline will cut emissions of air pollutants and reduce health problems, including premature deaths.

The Pollution Solution Begins with You

As a motorist, you can be part of the solution to climate change, urban smog and acid rain – and this Guide *aims to show you how.*

As explained in the following pages, reducing your impact on the environment and human health is simply a matter of making wise, energy-conscious decisions when buying, driving and maintaining your vehicle. If that's not incentive enough, think of the money you can save by being an Auto$mart driver. Read on – and good luck with your commitment to fuel efficiency and a cleaner environment.

[5] Environment Canada. For more information, visit "The Green Lane"* at **www.ec.gc.ca**.

Section 3

Buying a Fuel-Efficient Vehicle

QUICK READ

1. Fuel consumption can vary widely from one vehicle to the next. Whether you're buying new or used, the choices you make today will either save you money (through reduced fuel consumption) or cost you money for years to come.
2. How big is big enough? It's always a good idea to avoid buying more vehicle than you need because as vehicles get larger, they also tend to be heavier and have bigger or more powerful engines. So consider buying the most fuel-efficient vehicle that meets your needs.
3. If you're buying a new vehicle, check the EnerGuide label for its fuel consumption rating. EnerGuide labels are now affixed to all new light-duty vehicles sold in Canada.
4. Visit the Auto$mart Web site at **vehicles.gc.ca** for a list of the most recent winners of the EnerGuide Awards, presented each model year to the manufacturers of the most fuel-efficient vehicles in different classes – two-seater, subcompact, compact, mid-sized and large cars, as well as station wagons, vans, pickup trucks and special purpose vehicles.
5. Fuel consumption ratings for all new cars, light-duty trucks and vans sold in Canada are also available in the free *Fuel Consumption Guide*, which is published annually to help consumers shop for a fuel-efficient vehicle. Past editions are available, so you can check the fuel consumption rating for used vehicles, as well as new. Visit the Auto$mart Web site for the interactive version of the *Fuel Consumption Guide* or call 1 800 387-2000 to order your free copy.
6. Your choice of transmission will directly affect the cost of the vehicle and its fuel consumption. As a general rule, a manual transmission is more fuel-efficient than an automatic – assuming you shift properly. If you buy an automatic, the more gears the better.
7. Four-wheel drive offers superior traction and braking under slippery conditions, but the weight and friction of the additional drivetrain parts can increase fuel consumption by five to 10 percent compared to two-wheel drive vehicles. How often would you need to use this option, and is it worth the extra fuel costs for as long as you own the vehicle?

QUICK READ

8. Under normal driving conditions, smaller engines deliver better fuel economy than larger engines. Choose the smallest engine that meets your needs.
9. Are you willing to pay a fuel penalty for as long as you own the vehicle just to have the convenience of options such as power windows, seats and mirrors? Most options increase fuel consumption by adding weight, increasing aerodynamic drag, or drawing extra power from the engine.
10. Operating an air conditioner in hot weather can increase fuel consumption by more than 20 percent in city driving. Consider using the car's ventilation system and options such as a sunroof and tinted glass.
11. For most drivers, cruise control saves fuel on the highway by keeping your speed constant and avoiding inadvertent speeding.
12. Explore your fuel options. Will a fuel-efficient diesel vehicle meet your needs? What about propane or natural gas, which produce fewer greenhouse gas emissions and are cheaper to use than gasoline or diesel fuel? Ethanol fuel blends are also widely used by Canadian motorists. And hybrid electric vehicles, which use a combination of high-power batteries and an internal combustion engine, are appearing on the North American market.

There's no better time to make a commitment to fuel efficiency than when purchasing a vehicle. Whether you're buying new or used, chances are you will own the vehicle for some time – so the choices you make today will either save you money (through reduced fuel consumption) or cost you money for years to come. If you're interested in reducing your vehicle operating costs and helping the environment, purchase the most fuel-efficient vehicle that meets your everyday needs.

If you buy a gas guzzler today, and the price of gasoline goes up, you may find yourself with a car that has a low resale value.

Before making a final purchase decision, it's a good idea to ask yourself these questions:

- Do I really need a vehicle?
- How big is big enough?
- Should I buy new or used?
- Should I choose a manual or automatic transmission?
- Do I need two-wheel, four-wheel or all-wheel drive?
- What size engine do I need?
- Am I willing to pay a fuel penalty for certain options?
- Can I use a fuel other than gasoline?

Do You Need a Vehicle at All?

Much of this Guide *focuses on how you can reduce your fuel consumption to help the environment and save money. But what about the other costs of car ownership?*

There's the purchase price to consider, as well as your financial losses as the vehicle depreciates. And what about licensing and insuring the vehicle, and undertaking regular maintenance and repairs? All of these costs are high – the Canadian Automobile Association (CAA) estimates that it costs Canadians an average of more than $7,000 a year to drive a typical vehicle 12,000 km, more than $9,000 to drive 24,000 km and almost $11,000 to drive 32,000 km each year.[6]

[6] To calculate these figures, the CAA used a 1999 four-door sedan with a 2.2-litre, four-cylinder engine, automatic transmission, power steering, power disc brakes, AM-FM stereo, rear window defroster, speed control, tilt steering, block heater and heavy-duty battery. You can calculate your own vehicle costs on-line by visiting the CAA's Web site at **http://www.caa.ca**

So maybe your first decision should be whether you need to own a car at all. If you're living in an urban area, can you walk to your regular destinations? Can public transit meet your transportation needs, at a fraction of the cost of owning a vehicle? What about car pooling or ride sharing with your neighbours, friends or co-workers?

If you live within four kilometres of your regular destinations, why not walk or ride your bicycle? It will be good for the environment, your health and your pocketbook.

Not everyone has the option of using public transit – for millions of Canadians, car ownership is an absolute necessity. That's just one more reason to give your decision the careful thought it deserves.

How Big is Big Enough?

One of your first and most important decisions, at least from a fuel efficiency perspective, will be this: What size vehicle do you need?

Your range of choices is impressive. Can you get by with a fuel-efficient subcompact vehicle, or do you need a van, a pickup truck or maybe even one of the popular new sport utility vehicles?

It's always a good idea to avoid buying more vehicle than you need because as vehicles get larger, they also tend to be heavier and have bigger or more powerful engines. That combination results in increased fuel consumption and operating costs. As a rule, bigger vehicles are also more expensive to buy, so you get hit twice as hard in the pocketbook.

A 10 percent decrease in vehicle weight results in a six percent improvement in fuel consumption on flat terrain.

Begin by asking yourself how much space you need on a regular basis for passengers, luggage, tools, sports equipment, etc.? If you regularly carry three passengers or more, a four-door mid-size sedan makes sense. If you usually travel alone, and need a vehicle only to get yourself from point A to point B, a two-door subcompact car can fit the bill and is more economical. The same holds true for luggage, work supplies, groceries and so on. Do you really need the cargo space of a minivan or

pickup truck, or would a hatchback or small station wagon do the job?

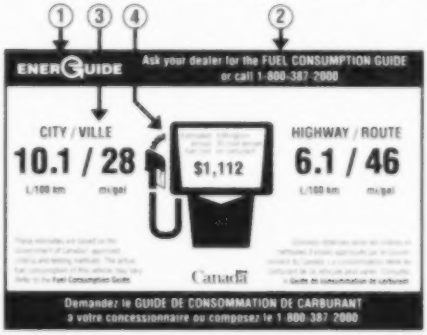
Buying a big vehicle to accommodate extra passengers or a heavy, bulky load once or twice a year could be an enormous waste of money. Why not install a trailer hitch instead, or rent a bigger vehicle on the few occasions when you might need one? The money you will save by driving a smaller vehicle the rest of the year could more than pay the cost of the rental. And you'll be saving wear and tear on your own vehicle at the same time.

Do you really need a van or sport utility vehicle for daily commuting? Don't buy a gas guzzler just because other people do. Generally speaking, the smaller and lighter the vehicle, the more fuel efficient it will be.

New or Used?

You will also have to decide whether to buy a new or used vehicle. Keep in mind that newer vehicles tend to be more fuel efficient than older models. The extra purchase price could be offset by reduced fuel costs and the peace of mind that comes with owning a new vehicle that is covered by a manufacturer's warranty.

If you're buying a new vehicle, check the EnerGuide label for its fuel consumption rating (see below for an explanation of the label). EnerGuide labels are now affixed to all new passenger cars and light-duty vehicles (not exceeding gross vehicle weight of 3855 kg/8500 lb.) sold in Canada. If a vehicle does not have an EnerGuide label, ask the dealer to see a copy or ask for the manufacturer's approved fuel consumption rating for that vehicle.



Check the EnerGuide label on all new vehicles. Fuel-efficient driving starts in the dealer's showroom.

Fuel consumption ratings are determined in a controlled laboratory setting, using government-approved methods, to ensure that all vehicles are tested under identical conditions. Although the actual fuel consumption you achieve will depend on many factors (including how and

where you drive, the season and local conditions, and the mechanical condition of your vehicle), these ratings are an excellent tool for comparing different vehicles on the basis of their fuel consumption and estimated annual fuel costs.

1. EnerGuide is the official Government of Canada mark for rating and labelling the energy consumption or energy efficiency of specific products, including major electrical household appliances, room air conditioners, new vehicles and houses.

2. Call 1 800 387-2000 (toll-free) to order your free copy of the *Fuel Consumption Guide* or any other energy efficiency publications.

3. Look for the lowest city and/or highway fuel consumption ratings in L/100 km, and find out which vehicle on your list will consume the least amount of fuel.

4. Use this figure to assess potential savings when comparing vehicles. This estimate is based on an annual distance travelled of 20,000 km, with 55 percent city and 45 percent highway driving, and the Canadian annual average fuel price at the pump for each type of fuel.

The EnerGuide Awards are presented each model year to the manufacturers of the most fuel-efficient vehicles sold in Canada. For a list of the most recent winners, visit the Auto$mart Web site at vehicles.gc.ca.

To order your free *Fuel Consumption Guide*, call the Auto$mart publications line at 1 800 387-2000.

Fuel consumption ratings for almost every new car, light-duty truck and van sold in Canada are also available in the free *Fuel Consumption Guide*, which is published annually by Natural Resources Canada's Office of Energy Efficiency to help consumers shop for a fuel-efficient vehicle. The *Guide* also provides estimated annual fuel consumption and costs of these vehicles.

After you've made some decisions about vehicle size and type, the engine and transmission, and other options, consult the *Fuel Consumption Guide* to compare different models

and select the most fuel-efficient vehicle for your needs. You can access the *Guide* on-line at **vehicles.gc.ca**, order a free copy by calling 1 800 387-2000, or ask your new car dealer for a copy. Past editions are available, so you can check the fuel consumption rating for used vehicles, as well as new.

Whether you're buying new or used, make a fuel-efficient choice.

Manual or Automatic Transmission?

Your vehicle's transmission transfers the power and torque developed by the engine to the drive wheels of the vehicle. Your choice of transmission will directly affect the cost of the vehicle and its fuel consumption.

As a general rule, a manual transmission with overdrive, combined with a tachometer or shift indicator, is more fuel efficient than an automatic (it's also usually cheaper to buy!). By shifting a manual transmission properly, you can expect to use 5 percent less fuel than if the vehicle had an automatic transmission. The manual advantage tends to be greatest on small cars with four-cylinder engines; bigger vehicles tend to benefit less from a manual transmission.

There are exceptions to this rule – in certain vehicles, an automatic transmission may in fact be more fuel efficient than a manual. The best way to check is to get a copy of the *Fuel Consumption Guide*, which provides fuel consumption ratings for both types of transmissions.

For a typical driver, proper use of a manual transmission can save at least 100 litres of fuel a year – just over two fill-ups.[7]

Having made this distinction between the two types of transmissions, it's also important to be aware of your driving patterns when making your choice. If you do mostly highway driving, a manual transmission will generally provide the best fuel economy – assuming, of course, that you use proper shifting techniques. If you have problems with the clutch or don't use the gears to their best advantage, your fuel and cost savings could be lost.

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[7] *The Transmission & Fuel Economy*, AutoSmart Fact Sheet Series (January 1999)

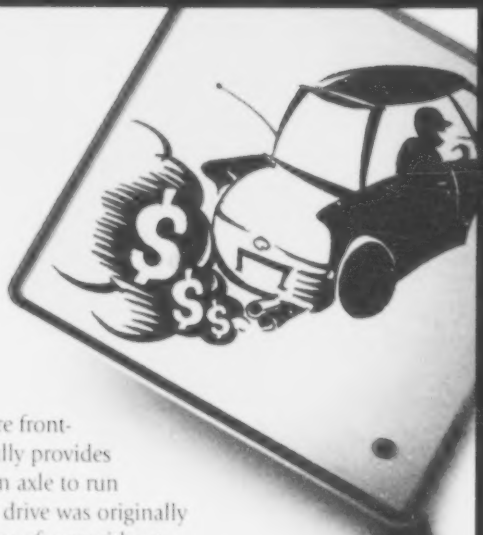
For city driving, or if you're not confident in your ability to handle a manual, an automatic transmission may be a better choice. Generally speaking, the more gears in an automatic transmission, the more fuel efficient the vehicle will be. This is because the extra gears are better able to keep the engine running at or near its most efficient level.

Typically, a four-speed overdrive transmission will be three to five percent more fuel efficient than a three-speed transmission. Overdrive gears decrease engine speed while maintaining vehicle speed, so you enjoy a triple windfall: lower fuel consumption, reduced engine wear and less engine noise. Some automakers even offer five-speed automatics, which can improve fuel efficiency by another three percent compared to a four-speed transmission.

When buying a vehicle with an automatic transmission, the Auto$mart choice is one with at least four gears, electronic controls and a lock-up torque converter.

For maximum fuel economy when purchasing a vehicle with an automatic transmission, consider an electronically controlled transmission with overdrive and a lock-up torque converter. The use of electronics has enabled engineers to design transmissions that precisely match power and torque requirements to engine speed, which improves fuel efficiency and makes for a smoother drive. The torque converter lock-up mechanism permits a direct mechanical connection to make the power transfer (similar to what occurs with a manual transmission) and can improve fuel economy by two to three percent. In addition, the more gears, the better.

Another new development is the continuously variable transmission, or CVT, a form of automatic transmission that uses belts and pulleys instead of gear wheels to allow an infinite number of gears (remember, the more gears the better). Although these transmissions were not in use in Canada as of fall 1999, they have achieved some success in reducing fuel consumption in Europe.



Do You Need Four-Wheel Drive?

Depending on the type and size of vehicle you buy, you may have a choice of front-wheel, rear-wheel, four-wheel or all-wheel drive. Sound confusing? Here's what you need to know from a fuel efficiency perspective.

The vast majority of passenger cars and minivans sold today are front-wheel drive, a configuration that offers better traction and generally provides more interior room than rear-wheel drive (there is no need for an axle to run from the transmission to the rear wheels). Although front-wheel drive was originally adopted to improve fuel economy by reducing the weight and size of cars without sacrificing driving qualities or interior space, today there is not much difference in fuel economy between the two types.

Four-wheel drive offers superior traction and braking under slippery conditions, but the weight and friction of the additional drivetrain parts can increase fuel consumption by 5 to 10 percent compared to two-wheel drive vehicles. Usually found on pickups and sport utility vehicles, four-wheel drive is engaged by the driver when extra traction is needed.

All-wheel drive – found on some sport utility vehicles and a handful of passenger cars – is another option. Full-time all-wheel drive is your least fuel efficient choice because all four wheels are always being "driven," or drawing power from the engine.

What Size Engine Do You Need?

When you purchase a new vehicle directly from a dealership, you may have more than one choice of engine. All other things being equal, the larger the engine (the greater the volume of the cylinders) and the more cylinders it has, the greater its fuel consumption (see table next page). As well, smaller engines usually cost less.

COMPARISON OF ENGINE SIZE AND FUEL CONSUMPTION

(Based on data from the 1999 *Fuel Consumption Guide*)

Vehicle	Engine Size	Annual Fuel Consumption	Annual Fuel Costs	Annual Savings From Smaller Engine
Mid-Sized Car	2.0 litre (4 cylinder)	1,584 litres	$919**	468 litres
	2.5 litre (6 cylinder)*	2,052 litres	$1,375	$271
Sport Utility Vehicle	4.0 litre (6 cylinder)	2,413 litres	$1,400	452 litres
	5.0 litre (8 cylinder)	2,865 litres	$1,662	$262
Pickup Truck	4.8 litre (8 cylinder)	2,542 litres	$1,474	370 litres
	5.7 litre (8 cylinder)	2,912 litres	$1,689	$215

*Premium gasoline specified at $0.67/litre. **Fuel costs based on $0.58/litre.

That does not mean that a bigger engine is never a good choice. For some applications, a larger, more powerful engine may be the most fuel-efficient option. If you often need to tow a heavy load, for example, a small engine may burn more fuel because it might have to work too hard and operate beyond its most fuel-efficient range.

Under normal driving conditions, smaller engines deliver better fuel economy than larger engines. Choose the smallest engine that meets your needs.

Vehicles with smaller, turbocharged engines can be efficient and may deliver some fuel and cost savings. However, most buyers select one of these devices to increase power output from a car's normal-size engine, a choice that tends to increase fuel consumption, especially if you frequently take advantage of the higher performance you've paid for.

Are You Willing to Pay a Fuel Penalty for All Those Extras?

Most new cars are available with a wide array of options, ranging from air conditioning to power windows to automatic seat warmers. If you're a "bells and whistles" type of person, you may want everything that's available. But there are two costs to consider: the purchase price of the option itself, and the ongoing cost it may impose through increased fuel consumption.

The fact is that most options increase fuel consumption in one of three ways: by adding weight, by increasing aerodynamic drag, or by drawing extra power either directly from the engine or through the alternator (which in turn is driven by the engine). Some may do all three.

Let's begin by talking about "power" equipment. The electricity drawn by power seats, sunroofs, windows, mirrors and door locks is relatively insignificant, in part because they are operated only briefly. Options that produce heat or light – such as seat heaters or fog lights – can be more of a drain on the alternator. If you select any of these latter options, they should be used only when necessary. Also, keep in mind that although power seats and power sunroofs don't consume much power, they are among the heavier options, and their extra weight will affect fuel consumption.

When considering power options, ask yourself whether the increased comfort or convenience they provide is worth the increase in fuel consumption.

Power seats can add 40 to 60 kg to a 1,200 kg vehicle, resulting in a two to three percent lifetime fuel consumption penalty.

In regions of Canada where summer temperatures are hot and humid, air conditioning has become a popular option. It can also be a costly one. Air conditioning saps power from the engine in two ways – mechanically, to operate the compressor, and electrically, to run the blower motor. Operating an air conditioner in hot weather can increase fuel consumption by more than 20 percent in city driving. Acceleration is also affected. Because the power required by the air-conditioning system is relatively constant, the smaller the engine, the greater the impact on fuel consumption.

Some of the more expensive vehicles have automatic climate control systems in which the air-conditioning compressor is on all the time (even in winter) to reduce the moisture content of the air in the car. It is estimated that these systems can increase fuel consumption by about five percent, so if you are in the market for one of these vehicles, look for a climate control system with an "economy" mode.

If you are buying a passenger van, you should be aware that some models have optional heating/air-conditioning booster systems for the rear seats. If the system consists of only an extra blower motor in the rear, it won't have much effect on fuel consumption. Another type of system, however, adds a second air-conditioning unit for the rear, almost doubling the impact on fuel economy.

A good ventilation system reduces the need to drive with the air conditioning on or the windows open. Open windows or sunroofs can be a fuel-saving alternative to air conditioning at low, city speeds, but at highway speeds they increase aerodynamic drag and fuel consumption. Some sunroof designs have a tilt function that boosts ventilation with minimal impact on the vehicle's aerodynamics.

Tinted glass, which blocks some of the sun's heat from entering the vehicle through its windows, can also reduce the need for air conditioning and help you save fuel. Tinted glass can also be installed on basically any vehicle – new or used.

A block heater is one option that can significantly improve fuel economy and reduce harmful exhaust emissions. By enabling you to start your engine semi-warm, it can improve overall winter fuel economy by as much as 10 percent. For more information on the benefits of a block heater, see page 40.

Remote car starters encourage people to start their cars before they are ready to drive them. This promotes unnecessary idling, which wastes fuel.

Aluminum wheels are one of the few options that actually reduce weight and improve fuel economy. Heavy-duty suspension systems improve handling and are stronger and longer lasting than standard suspension systems. The extra weight, cost and fuel consumption are nominal.

For most drivers, cruise control saves fuel on the open road by keeping your speed constant and avoiding inadvertent speeding. If you are purchasing a manual transmission, another good instrument to have in your vehicle is a tachometer, which indicates engine speed. A tachometer can help you shift the transmission at the most fuel-efficient engine speeds (the owner's manual will tell you these speeds). Some cars have a shift indicator light that performs a similar function.

Roof racks, even when empty, increase aerodynamic drag. In the case of permanent, factory-installed units, the drag may be minimal but it's always there. Removable roof racks may be a better option, since they cause more drag only when they're installed. The use of removable roof racks can also allow you to purchase a smaller car.

Some vehicles can be purchased with trip computers or navigation systems. Although trip computers don't directly affect fuel economy, they can show you how much fuel you are using and challenge you to do better. Navigation systems can save fuel by showing you the most direct route from point A to point B.

Compare Options for Fuel Efficiency

Fuel-Consuming Options	Fuel-Saving Options
Air conditioning can increase fuel consumption by more than 20 percent in city driving because of the extra load placed on the engine.	Use the ventilation system to replace the air inside the car and keep cool as you drive. This means the air conditioner doesn't need to be on all the time.
An open sunroof at highway speeds increases aerodynamic drag, which in turn increases fuel consumption.	In city driving, an open sunroof can help replace the air inside the car as you drive, thereby reducing the need to use the air conditioner. Tinted glass helps reduce the heat buildup inside the car as it sits in the sunshine. This reduces the amount of cooling required by the air conditioner.
A roof rack – loaded or empty – can increase fuel consumption by increasing aerodynamic drag.	A removable roof rack can be detached when not required. It can also allow you to buy a smaller car and use the roof rack on those occasions when you have extra luggage or equipment to carry.
Power seats, windows and mirrors add weight to the vehicle and draw extra energy from the engine, both of which increase fuel consumption.	If your car is equipped with a manual transmission, a tachometer or shift indicator light can tell you when it's time to shift to the next gear. This will lower the engine speed and save fuel without slowing the vehicle speed.

Fuel-Consuming Options (contd.)

Heated seats add weight and require significant electrical energy when in operation. Both the extra weight and the higher electricity demand cause the engine to burn more fuel.

Remote car starters encourage people to start their cars before they are ready to drive them. This promotes unnecessary idling, which wastes fuel.

Fuel-Saving Options (contd.)

Cruise control allows the vehicle to maintain a set speed without depressing the accelerator. Maintaining a reasonable and consistent speed is safe, fuel-efficient driving.

A block heater heats the engine block, which helps the vehicle start in cold temperatures and promotes a quicker warm-up of the vehicle interior.

For more information on the cost of owning, driving and maintaining your vehicle, visit the Canadian Automobile Association's Web site at **http://www.caa.ca** or write to the CAA and ask for the free brochure, *Car Costs*. See page 64 for the CAA's address.

Can You Use an Alternative to Gasoline?

Gasoline is the predominant fuel used in personal vehicles across Canada, but it's not your only option.

For example, some manufacturers offer diesel engines in a few models of light-duty trucks and passenger cars. The diesel engine is essentially the same as a gasoline engine, except that it has a much higher compression ratio, so the fuel self-ignites without the need for a spark. Diesel engines have glow plugs or other devices that raise the temperature in the cylinder to facilitate the initial fuel combustion and cold starts. After that, the process is self-supporting.

Diesel engines are much more fuel-efficient than gasoline engines, especially in city driving conditions. Best of all are direct-injection (DI) diesel engines, which inject fuel directly into the main combustion chamber instead of a pre-combustion chamber (as is done with conventional diesel engines).

Some manufacturers also offer a limited number of models that are built especially to operate on natural gas or propane. These alternative fuels are available in many parts of Canada, cost generally less than gasoline, create fewer greenhouse gases and are very cost-effective for high-mileage vehicles, such as taxicabs and police cars. Vehicles can also be converted to propane or natural gas after

they've left the manufacturer's plant. However, these after-market conversions are not as efficient as original equipment models because the engines are not as well matched to the fuels.

For optimum vehicle performance and fuel economy, use only the fuel recommended in the owner's manual.

If diesel fuel, propane or natural gas are not options for you – and they are not the right choice for all motorists – consider joining thousands of other Canadians using ethanol-enhanced gasoline, often referred to as "gasohol." Gasoline blends with up to 10 percent ethanol are sold at several hundred service stations in Canada and can be used in virtually all gasoline vehicles sold in North America. The use of ethanol reduces the vehicle's emissions but may increase fuel consumption by one to two percent because ethanol reduces the fuel's energy content. Check your owner's manual before using an ethanol-blended fuel.

Another clean-burning option available from some North American automakers is the E85-fuelled vehicle. E85 is a blend of gasoline and up to 85 percent ethanol. Because E85 is not yet widely available as a transportation fuel, these vehicles are designed as "flexible-fuel vehicles" and are able to operate on straight gasoline or any blend of gasoline and E85. For Canadian motorists, E85 is not currently a viable fuel because of the lack of refuelling facilities.

Domestic and foreign automakers have also developed hybrid electric vehicles, which became available in Canada in the 2000 model year. These vehicles use two on-board power sources, one of which is an electric motor driven by high-power batteries (the second source is usually an internal combustion engine running on gasoline or diesel fuel). Hybrid electric vehicles can provide up to 50 percent better fuel economy than a similar gasoline-powered vehicle, and no additional infrastructure is required to own or operate the vehicle.

So what's the bottom line on alternatives to gasoline? In most cases, there are fewer refuelling stations than for gasoline, so some of the alternatives may be difficult to obtain. On the positive side, these alternatives generate fewer greenhouse gas emissions and can be cheaper to operate than gasoline vehicles.

For more detailed information on alternative transportation fuels, see "Alternatives to Gasoline" on page 55.

Section 4

Driving the Auto$mart Way

QUICK READ

1. Your personal driving habits will have a big impact on your fuel consumption and costs. You can control the costs of operating a vehicle and minimize the emissions it produces by making a commitment to drive less and to drive more efficiently.
2. Use public transit whenever possible. A single city bus can take 40 vehicles off the road, save 10,646 litres of fuel and keep 25 tonnes of GHG emissions out of the atmosphere each year. Try ride sharing or car/van pooling.
3. Driving the Auto$mart way means planning your trip carefully to combine errands, avoid traffic jams, steep hills, road construction, etc. Give yourself time – racing against the clock causes you to brake hard, accelerate quickly and drive too fast, all of which waste fuel.
4. Aggressive driving saves little time, wastes fuel, increases emissions and causes excessive engine and brake wear. Auto$mart driving is safe driving. Anticipate what is happening ahead of you on the road and react accordingly.
5. Drive at the posted speed limit. Increasing your highway cruising speed from 100 km/h to 120 km/h will increase fuel consumption by about 20 percent.
6. Idling is an enormous waste of fuel and money, and excessive idling can be hard on the engine. Except at a traffic signal or in slow-moving traffic, Auto$mart drivers make a habit of turning off the engine if they are going to be stopped for 10 seconds or more.
7. You can improve your fuel efficiency in summer by minimizing your use of air conditioning. To stay cool at highway speeds, use your car's flow-through ventilation. When driving in the city, open a window.

QUICK READ

8. In winter, use a block heater to warm your engine before you start it. A cold engine is at its worst in terms of fuel consumption and exhaust emissions. Block heaters can improve overall winter fuel economy by as much as 10 percent.

9. Once a vehicle is running, the best way to warm it up is to drive it. You need no more than 30 seconds of idling on winter days before driving away. Anything more simply wastes fuel and increases emissions.

10. Your tires need special attention during winter. Cold temperatures decrease the air pressure in tires, which just adds to the rolling resistance caused by snow and slush. Check tire pressures regularly, especially after there has been a sharp drop in temperature.

Looking for painless ways to save money and reduce vehicle emissions? Remember, you're in the driver's seat!

Your driving habits – when and where you drive, how often, the speed you travel, your aggressiveness on the road and other factors – will have a huge impact on your fuel consumption and costs. And it's never too late to learn how to drive the Auto$mart way.

You can control the costs of operating a vehicle and minimize the emissions it produces by making a commitment to drive less and to drive more efficiently. This section provides some basic information on how to drive the Auto$mart way, and tells you how to get formal training in fuel-efficient driving techniques.

Plan Ahead

Driving the Auto$mart way requires some planning. If you have errands to run, think ahead and plan your route to avoid backtracking or sitting in traffic jams at rush hour. Sometimes a somewhat longer route that lets you maintain a steady speed can be more fuel efficient than a shorter route with a lot of traffic lights. Avoid routes that have steep hills that require your vehicle's engine to work harder.

Leave Your Car at Home

Using public transit as often as possible will be cheaper than driving everywhere you want to go, and it can be much less stressful. Leaving your car at home will have an immediate and direct impact on greenhouse gas emissions. A single city bus can take 40 vehicles off the road, save 10,646 litres of fuel and keep 25 tonnes of GHG emissions out of the atmosphere each year.

Car and van pools are another excellent way to save money and reduce emissions. An average van pool of seven passengers emits about 7.5 times less pollution per kilometre than drive-alone commuting. Vancouver, Toronto, Montréal and Halifax are among the Canadian cities that have van pool programs.

Give yourself enough time to get where you're going – racing against the clock causes you to brake hard, accelerate quickly and drive too fast, all of which burn fuel needlessly. Listen to the radio for traffic reports on accidents, road construction and other trouble spots to avoid – you'll save time as well as gas.

Keep in mind that short trips can be especially hard on your pocketbook. Trips of less than five kilometres generally do not allow the engine to reach its peak operating temperature (especially in cold weather), and that means fuel consumption and exhaust emissions will be significantly higher than when covering the same distance with a warm engine.

***Keep track of your vehicle's fuel consumption on a per-kilometre basis – and then challenge yourself to reduce it. Call 1 800 387-2000 for a copy of Auto$mart's handy tool, the* Car Economy Calculator.**

Planning is also important for long-distance trips. Use the latest road maps available to plan your route, keeping in mind that the most direct route is not always the best. For example, you might want

to avoid driving through suburban areas (use bypass roads around major cities), since stop lights, intersections and pedestrian traffic all mean multiple stops and starts and extra fuel consumption. When planning your route, keep in mind that using a four-lane highway is generally more fuel efficient than using a two-lane highway.

Auto$mart Driving is Defensive Driving

Auto$mart driving is safe driving. You can save fuel, reduce exhaust emissions and protect yourself and your family on the road by practising defensive driving techniques – in other words, by anticipating what is happening ahead of you on the road and reacting accordingly.

Accelerating is by far the "thirstiest" work you can ask your car to do. Hard, fast acceleration guzzles gas and wears out your engine and tires quicker. You can minimize the need to accelerate by avoiding unnecessary slowdowns or holdups in the first place. That means trying to anticipate traffic disruptions so you can maintain a steady speed. For example, rushing up to a red light or stop sign and then braking at the last minute is a futile and costly habit that wastes fuel and wears out the brakes. Instead, take your foot off the accelerator well in advance of the intersection and coast toward it. If there's a red light, chances are it will turn green before you get there, so you won't even have to stop.

Aggressive driving in city traffic saves very little time but greatly increases fuel consumption and emissions. A European test showed that aggressive driving – "jackrabbit" starts from traffic lights and hard braking – reduced travel time by only four percent (the equivalent of 2.5 minutes out of a 60-minute trip).[8] However, fuel consumption increased by 39 percent, and some toxic emissions were more than five times higher. The safer, more fuel-efficient option is to accelerate smoothly and maintain a steady speed.

The same holds true for highway driving. It takes energy to get the vehicle up to cruising speed, and that energy is lost every time the vehicle is forced to slow down unnecessarily – for example, if you approach other vehicles too quickly. Accelerate smoothly when passing other cars or when merging with faster traffic, and leave plenty of room between your vehicle and the one in front of you to avoid hard braking.

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8 Lenaers, G. and De Vlieger, I. "Moderate Driving Behaviour Cuts Fuel Consumption." *Energy Conservation in Transport.* CADDET Newsletter No. 4, December 1995.

Teaching Student Drivers the Auto$mart Way

Every year, some 300,000 Canadians, most of whom are under 21 years of age, register in driver education programs. If you have a novice driver in the family and you want to get him or her started on the right foot in terms of fuel efficiency, look for a driving school that uses the Auto$mart Student Driving Kit.

The kit has been especially designed to help driver instructors deliver fuel efficiency training to Canadian teens. It includes an entertaining 40-minute video that informs viewers how to drive efficiently, when to drive (when you cannot walk or use public transit), and how to buy and maintain a vehicle with fuel efficiency in mind. Its message is simple: what's good for your car is also good for your wallet, the environment and clean, healthy air.

Call 1 800 387-2000 or visit the Auto$mart Web site at vehicles.gc.ca for a list of driver trainers who teach Auto$mart techniques.

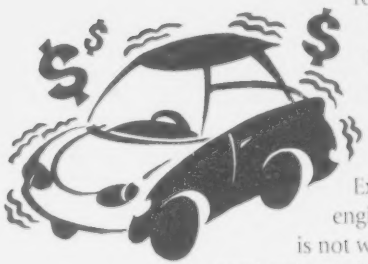
In most vehicles, increasing your cruising speed from 100 km/h to 120 km/h will increase fuel consumption by about 20 percent. On the other hand, reducing your speed from 100 km/h to 90 km/h improves fuel economy by about 10 percent.

As noted in the previous section, most drivers will save fuel by using cruise control to maintain a constant speed on the highway. In certain circumstances, however, skilled driving can be more fuel efficient than using cruise control. In hilly terrain, for example, it's more fuel efficient to let your speed drop going uphill and build it up again going down the other side. In practice, however, traffic conditions rarely permit such a technique.

Some motorists tend to drive with their left foot resting on the brake pedal, a habit that increases fuel consumption and wears out the brakes prematurely. It can also be dangerous because it causes heat buildup in the brakes, which reduces braking power. In addition, your brake lights stay on all the time, which means that motorists travelling behind you have no warning when you actually apply the brakes to slow down or stop.

Don't Be an Idler

Idling gets you nowhere – and it can be costly. Excessive idling represents an enormous waste of fuel and money and generates unnecessary greenhouse gas emissions.



Ten seconds of idling can use more fuel than turning off the engine and restarting it again. Every 10 minutes of idling costs you at least one tenth of a litre in wasted fuel – and up to four tenths of a litre if your vehicle has an eight-cylinder engine. Except at a traffic signal or in slow-moving traffic, Auto$mart drivers make a habit of turning off the engine if they are going to be stopped for 10 seconds or more.

Excessive idling can also be hard on your engine. Idling contaminates engine oil more quickly than when a vehicle is moving because the engine is not working at its designed operating temperature, which means that fuel combustion is incomplete and some fuel residues condense on cylinder walls. In addition to contaminating the oil, these unburned fuel deposits can also damage engine components.

A study conducted for the Office of Energy Efficiency concluded that restarting a vehicle numerous times (as opposed to leaving it idling) has a relatively small impact on engine components such as the battery and starter motor.[9] The study estimates that component wear caused by restarting the engine adds $10 per year to the cost of driving, which will likely be recovered several times over in fuel-cost savings.

If every Canadian motorist avoided idling their vehicle for just five minutes per day, more than 1.4 million tonnes of CO_2 would be spared from entering the atmosphere and contributing to climate change.

Some motorists believe idling helps warm up the vehicle. In fact, it only warms the engine. As you'll learn later (in the section on winter driving), the best way to warm all of the vehicle's components is to drive it.

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9 *Idling Versus Restarting for Light Duty Vehicles*, Jack Patriarche, MBA, P.Eng., Patriarche & Associates, February 1999.

Other Auto$mart Tips

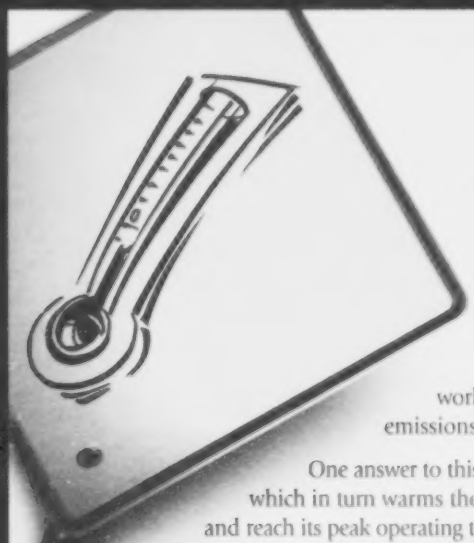
To get full benefit from a manual transmission, shift up to the next gear as soon as possible and always keep the vehicle in the highest gear possible without "lugging." Most modern cars can run in top gear even at speeds below 60 km/h.

- You can improve your fuel efficiency in summer by minimizing your use of air conditioning. To stay cool at highway speeds, use your car's flow-through ventilation. In the city, open a window. The impact of aerodynamic drag is relatively small at low speeds, so your car will hardly feel the increased drag caused by an open window. If you still need air conditioning, keep the windows closed and switch the air conditioner on and off only as needed.
- Your vehicle could stand to loose a few pounds. Those heavy bags of sand and salt you may carry around in your trunk during winter serve no useful purpose in spring, summer and fall. The extra weight just means wasted fuel and unnecessary emissions. Treat your trunk to a spring cleaning!
- Ski racks, like roof racks, increase a vehicle's aerodynamic drag. It's a good idea to remove them when they are not in use.

The Challenges of Fuel-Efficient Winter Driving

Fuel consumption soars in cold weather – sometimes by as much as 50 percent – and that's hard on your pocketbook and on the environment.

Fuel consumption and pollution output are much higher in the first minute or two after a cold start than when the engine has achieved normal operating temperatures. One reason is that when your engine starts up, it has to pump oil throughout the block to lubricate moving parts. In a cold engine, the oil is thick and resists flow, which means the engine has to work harder to overcome internal friction. Thick oil also takes longer to circulate, which allows metal-to-metal contact and increases engine wear.



An engine can burn up to 50 percent more fuel for a short trip in the winter than for the same trip in the summer.

Fuel combustion is also much less efficient in a cold engine, and the air-fuel mixture is richer (i.e., more fuel, less air). The combined effect is a sharp increase in pollutants. To make matters worse, the catalytic converter doesn't work when it is cold. Until the converter warms up, all of the engine's emissions pass through the exhaust untreated.

One answer to this cold-engine dilemma is to use a block heater to warm the coolant, which in turn warms the engine block and lubricants. The engine will start more easily and reach its peak operating temperature faster. In temperatures of –20°C, block heaters can improve overall fuel economy by as much as 10 percent or more.

Use an automatic timer to switch on the block heater two hours before you plan to drive the vehicle. This is all the time needed to warm the engine.

Once a vehicle is running, the best way to warm it up is to drive it. With computer-controlled, fuel-injected engines, you need no more than 30 seconds of idling on winter days before driving away. Anything more simply wastes fuel and increases emissions.

Besides, more than the engine needs to be warmed up – so do the wheel bearings, steering, suspension, transmission and tires, all of which can be done only when the vehicle is moving. A typical vehicle must be driven for at least five kilometres to warm up these parts.

Although it is important to drive away as soon as possible after a cold start (but not before the windows are defrosted!), you should avoid high speeds and rapid acceleration for the first five kilometres or so. The goal is to bring the whole vehicle up to peak operating temperature as quickly as possible while maximizing fuel economy.

To prevent your car windows from fogging up, open a window as soon as you enter the vehicle. Clear snow from the air intake on top of the hood. Otherwise, the defroster will draw moisture into the system and fog the windshield.

You already know that extra weight increases fuel consumption. As snow builds up in wheel wells and under bumpers, it adds weight and rubs against tires, further increasing rolling resistance. And snow piled on top of the vehicle increases aerodynamic drag, as well as vehicle weight. For safety as well as fuel economy, clear snow off your vehicle before you drive away.

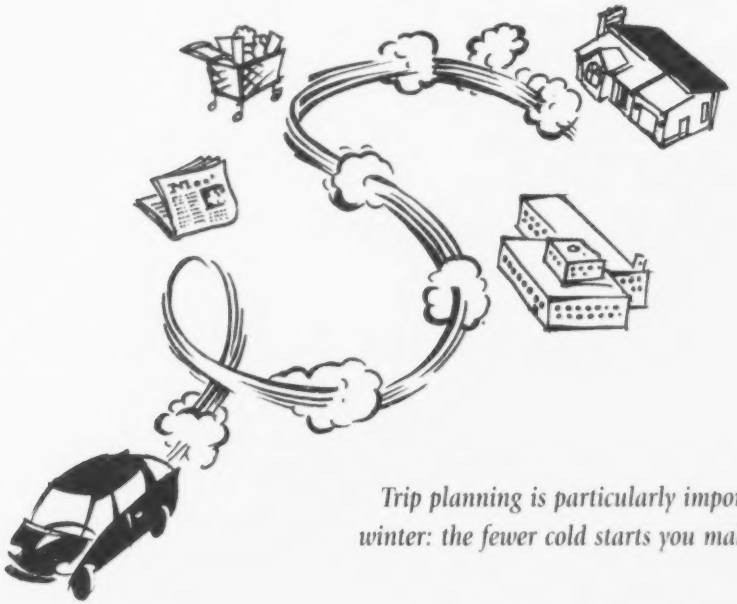
Your tires need special attention during the winter. Cold temperatures decrease the air pressure in tires, which just adds to the rolling resistance caused by snow and slush. Each tire that is under-inflated by 8 psi (56 kPa) causes four percent increase in fuel consumption. So check tire pressures regularly, especially after there has been a sharp drop in temperature.

As you will learn in the following section, correct tire pressure is vital for fuel economy, safe vehicle handling and long tire life. Before adding air to your tires, let some air out of each valve and blow some air out of the hose. This prevents moisture from gathering in the tire valve, where it can freeze and cause the valve to leak. As well, use your own tire pressure gauge, since the gauges built into air pumps at service stations are often inaccurate or missing.

For most Canadian drivers, all-season radial tires are sufficient for winter driving. City and suburban dwellers do not need snow tires, which have a heavy tread that increases rolling resistance and fuel consumption. On the other hand, if you live in an area where roads are regularly snow-covered, snow tires will improve traction, reduce tire slippage, improve safety and save fuel. For the best results, use snow tires on all four wheels. All-season tires do not provide the same grip at temperatures below –15°C.

Trip planning is particularly important in the winter: the fewer cold starts you make, the better. Instead of several quick trips, combine all your errands into one run and select your route carefully. Chances are the engine will stay relatively warm while you are out of the vehicle (don't idle), which will minimize fuel consumption and pollution levels when you restart it. Avoid up-hill parking so that it will be easier to pull away when it's time to leave.

One last tip for winter driving – take it easy. The more your vehicle slips and slides and spins its wheels, the more fuel you waste and the chance of an accident is increased. You will also need more room to stop in winter conditions, so increase the distance between you and the vehicle in front.



Trip planning is particularly important in the winter: the fewer cold starts you make, the better.

Section 5

Keeping Your Car in Shape

QUICK READ

1. Keeping your vehicle in top operating condition will save you fuel and money, reduce your long-term maintenance costs and minimize harmful exhaust emissions. A well-maintained vehicle is also more reliable and could be worth more when you want to sell it.
2. Read the owner's manual carefully to become familiar with your vehicle's maintenance schedule and requirements. Maintenance regimes vary widely from one vehicle to another, and the manufacturer knows best.
3. In most cases its best to leave the servicing of your vehicle in the hands of trained automotive professionals. They have the knowledge and tools to diagnose and correct problems and to put you on the road to safe, fuel-efficient driving.
4. When purchasing motor oil, look for a brand that is rated as being "Energy Conserving." Using the lowest multigrade of oil recommended in your owner's manual can improve the fuel efficiency of the engine, particularly when starting it cold.
5. Virtually all of your vehicle's mechanical systems can affect fuel efficiency in one way or another if not properly maintained. Follow the manufacturer's recommendations for engine, cooling and ignition system, brake, drivetrain and emission control system checks.
6. Operating a vehicle with just one tire under-inflated by 6 psi (40 kPa) can reduce the life of the tire by 10,000 km and increase the vehicle's fuel consumption by three percent. For improved fuel efficiency and enhanced safety, give your tires the attention they need.
7. Head off problems that can cost you fuel and money by performing the monthly check described on page 54.

Buying a fuel-efficient car and driving it the Auto$mart way will start you on the road to fuel and cost savings. The third thing you need to do is keep your car in top shape through regular maintenance.

Why is maintenance important? Consider this:

- A poorly maintained vehicle can increase fuel consumption by up to 50 percent and environmental emissions by even more.
- A clogged air filter can increase fuel consumption by 10 percent.
- Under-inflated tires are estimated to cost Canadian light-duty vehicle owners almost 400 million litres of fuel annually.[10] At an average fuel price of $0.58 per litre for regular unleaded gasoline, that amounts to $232 million a year in wasted fuel.
- Neglecting to replace worn-out oil results in poor engine performance, higher fuel consumption and possibly severe engine damage.
- A well-maintained vehicle is more reliable and could be worth more when you want to sell it.

To ensure maximum fuel economy and prevent the manufacturer's warranty from being voided, your vehicle must be maintained to the standards recommended in the owner's manual.

This section provides general information and helpful tips on maintaining your vehicle for fuel efficiency. ***It is not intended to replace the manufacturer's maintenance instructions.***

Read the Owner's Manual

The best way to keep your vehicle running clean, lean and green is to follow the maintenance instructions in the owner's manual. The manual will tell you everything from how often the vehicle's oil should be changed and what type of oil to use, to recommended intervals for engine and transmission checks. Failure to comply with this maintenance regime can result in voiding your warranty.

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[10] Natural Resources Canada: *Report to Parliament on the Administration and Enforcement of the Energy Efficiency Act, 1994–95. Cat. No. M92-73/1995E*

If you don't have an owner's manual for your vehicle, contact the dealer or manufacturer and ask for a copy. Don't guess at maintenance – and don't rely on the advice of friends, neighbours or family members. Maintenance requirements vary widely from one vehicle to another.

With today's sophisticated engines and on-board computer systems, it just makes sense to leave the servicing of your vehicle in the hands of trained automotive professionals. They have the knowledge and tools to diagnose and correct problems and to put you on the road to safe, fuel-efficient driving.

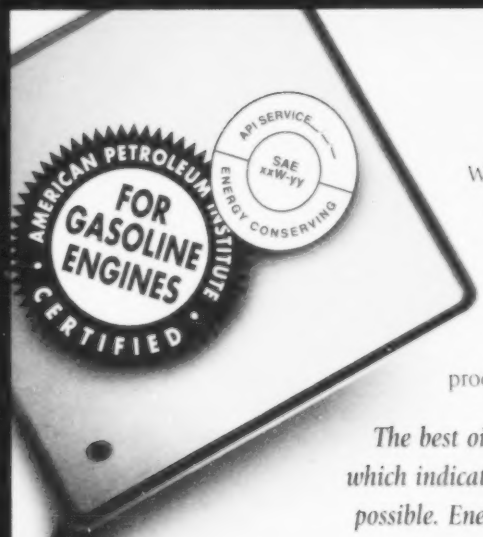
That doesn't mean you should ignore your vehicle between scheduled maintenance checks or until you have a breakdown. By understanding how different vehicle components affect fuel efficiency, you can better appreciate the importance of maintenance and your role in keeping your vehicle in peak running condition.

The Lubrication System – A Word About Engine Oil

Changing the engine oil on a regular basis, according to the manufacturer's recommendations, is one of the best ways to keep your vehicle in top operating condition. Oil lubricates the moving parts of the engine, preventing metal-to-metal contact, minimizing friction and carrying away excess heat – all of which promote better fuel efficiency and reduced emissions. Motor oil also removes dirt, metal shavings and other impurities from the engine and captures them in the oil filter. You can pay a severe penalty for neglecting engine oil, possibly even needing to replace the engine itself.

For best engine performance, fuel efficiency and reduced emissions, use only the oil recommended in the owner's manual. Some manufacturers specifically advise against using oil additives.

Most engine oils sold for light-duty vehicles are multigrades, shown on the label as 10W30 or 5W30. Today's vehicles are generally designed to use 5W30 oil year-round, although some manufacturers are beginning to specify 10W30 oil. Older vehicles will probably need 10W30 in summer but can be switched to 5W30 in winter. By using the lowest multigrade of oil recommended in your owner's manual, you can improve the fuel efficiency of the engine, particularly when starting it cold.



When purchasing motor oil, look for the two labels shown at left. The label on the right appears on virtually all motor oils sold in Canada. The middle of the label shows the multigrade (e.g., it might read 5W30). At the top is the oil's service rating, and at the bottom is its rating as "Energy Conserving." If the label on the far left also appears on the container, the oil has passed a series of rigorous tests and product quality audits of oils on the automotive retailer's shelf.

The best oils for fuel economy carry the label "Energy Conserving," which indicates that the oil has been treated to make it as slippery as possible. Energy-conserving oils reduce fuel consumption by 2.7 percent or more compared to a reference oil.

You might want to consider using a re-refined motor oil in your vehicle as an alternative to "virgin" oil products. Engine oil recovered from oil changes is taken to a recycling plant and rejuvenated. The necessary detergents and additives are replaced in the oil, and impurities are removed. The result is an oil that has similar properties to mainstream motor oil products. Re-refined oil certified with the "EcoLogo" mark performs as well as motor oil from original sources.

If you change the oil yourself, take the old oil to your service station for recycling. One litre of engine oil can contaminate two million litres of water.

Synthetic oils also offer an advantage over mineral oils, particularly under extreme weather or performance conditions. Synthetic motor oil is manufactured, rather than refined from crude oil, which means it can be specially formulated to have extremely good flow characteristics and resistance to viscosity breakdown. However, keep in mind that synthetic oil is more expensive than conventional motor oil.

Cooling System

The role of the cooling system is to keep the engine at its optimal operating temperature. Outside this range, fuel consumption, emissions and engine wear will increase.

Regular maintenance is needed to ensure proper performance of the cooling system. This includes monitoring the coolant level in the overflow tank, regularly inspecting hoses for cracks or loose clamps, and adjusting belts, where applicable (most new vehicles have self-tensioning belts). It's important to change the coolant at the interval specified by the manufacturer, as it will degrade over time. Antifreeze concentration should also be tested every fall to ensure the engine is adequately protected for the winter.

Ignition System

Regular maintenance of your vehicle's ignition system is also critical to achieve maximum fuel efficiency and minimum greenhouse gas emissions.

The spark plugs in a gasoline engine ignite the air-fuel mixture. If one or more of the plugs is worn or malfunctioning, the engine will misfire, which results in unburned fuel. Worn or damaged spark plug wires can also cause misfiring. A misfiring engine wastes fuel, produces higher levels of emissions and generally performs poorly.

Unburned fuel can cause the catalytic converter to overheat and fail, resulting in a costly repair bill.

Signs of misfiring can be subtle, which is why it is important to follow the manufacturer's recommendations on engine checks and spark plug and ignition wire replacement. Regular spark plugs typically last 48,000 km, while the long-life platinum plugs can last 160,000 km. Some manufacturers recommend that spark plug wires be changed at 96,000 km; others suggest they be replaced only as required.

The cost of ignition system maintenance can be easily recovered in fuel savings – and the environment will benefit too.

Some vehicles (those with distributors) will require additional ignition system maintenance, which is another good reason to have your engine tuned up regularly.

Drivetrain

Keeping your vehicle's drivetrain working efficiently promotes fuel economy. That means checking fluid levels, changing fluids as required and keeping certain components lubricated. Requirements vary, so it's important to check your owner's manual.

Steering and Suspension System

The steering system can have a substantial impact on fuel economy, since even a small wheel misalignment increases fuel consumption. Misalignment will also wear out tires long before their time.

If you notice unusual tire wear or find the vehicle pulling to one side, chances are you need an alignment. Even if neither of these signs appears, follow the manufacturer's recommendations for checking wheel alignment to avoid paying a penalty in increased fuel and tire costs. The power steering fluid should also be checked regularly.

The cost of a wheel alignment is low compared to the amount of money it can save you in fuel and tire expenses.

Emission Control System

Modern vehicles are equipped with an emission control system to treat exhaust emissions before they are released into the atmosphere. This system must be inspected and maintained according to the manufacturer's recommendations – otherwise, your vehicle could be a major polluter.

If you experience problems such as stalling or poor acceleration, or if your exhaust produces black or blue smoke, your vehicle is probably polluting the air and needs servicing.

Vehicles manufactured after 1996 have an on-board diagnostics system that will monitor emission-related components and alert the driver to problems by triggering the "Service Engine Soon" or "Check Engine" light. By detecting problems before they become noticeable to the driver, this system can help you avoid hefty repair bills. Should one of these warning lights come on, consult your owner's manual for instructions. For vehicles manufactured before 1996, the only way to be sure the emission control system is working is to have it tested.

A study of 124 vehicles that failed an emission test conducted under the Government of British Columbia's AirCare program showed that fuel consumption improved by 15 percent when the emission control system was repaired. For the average driver, that represents a savings of $200 a year in fuel alone.[11]

Brakes

Dragging brakes (when the brake pad or shoe fails to release from the disc or drum) can significantly increase fuel consumption because the vehicle must work harder to overcome the resistance. This also reduces brake life and effectiveness, making the vehicle harder to drive. It is important to have your brakes inspected and the brake fluid checked and changed at the interval specified in the owner's manual.

Warning signs that your brakes need servicing include squealing and grinding noises, brake fade (loss of braking effectiveness because of excess heat in the brakes), pulling of the vehicle to one side, or a "soft" or pulsating brake pedal. For information on how to check for brake problems, see page 54.

If you wait too long to have your brakes serviced, the pads and shoes can wear to the point where they damage other components and increase your repair costs.

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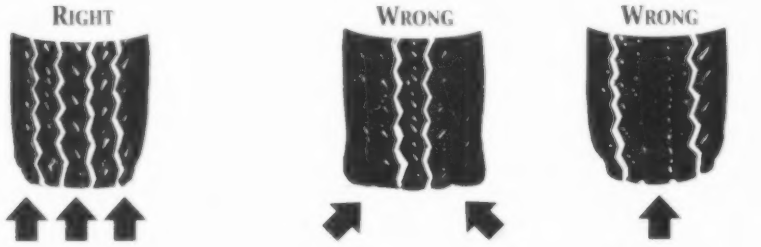
11 *Controlling Vehicle Emissions*, AutoSmart Fact Sheet Series (January 1999)

Don't Forget Your Tires

Here's where the rubber meets the road! Rolling resistance is a key factor affecting a vehicle's fuel efficiency, and the best way to reduce rolling resistance is to maintain correct tire pressure. Operating a vehicle with just one tire under-inflated by 6 psi (41 kPa) can reduce the life of the tire by 10,000 km and will increase the vehicle's fuel consumption by three percent.


RIGHT
WRONG
WRONG
NORMAL WEAR PATTERN EVENLY DISTRIBUTED ACROSS TIRE
EXCESSIVE WEAR ON OUTSIDE SHOULDERS INDICATING CHRONIC UNDER-INFLATION
EXCESSIVE WEAR IN CENTRE OF TIRE INDICATING CHRONIC OVERINFLATION

If every Canadian motorist maintained correct tire pressure and avoided under-inflation we would prevent 1.5 million tonnes of CO_2 from entering the atmosphere.

As noted earlier, tire pressure needs special attention in cold weather. Tire pressure drops by about 1 psi (7 kPa) for every 5°C drop in temperature. Tires also lose a certain amount of pressure due to their permeability – by some estimates, as much as 2 psi (14 kPa) per month.

Regular tire inspections are therefore crucial to improving your fuel economy and reducing emissions. This inspection should include:

- A check of tire pressure at least once a month when the tires are cold (for information on how to properly check and adjust tire pressure, see page 51). The vehicle manufacturer's recommended pressure for the front and rear tires is specified on a plate or sticker attached to the edge of the

driver's door, the door post, the glove box or the fuel door (the pressure marked on the tire itself is the maximum pressure and is not likely to be the same as the manufacturer's recommended pressure). If you can't find the plate, check the owner's manual or consult your dealer. And don't forget to check the pressure of the spare tire – you never know when you might need it.

- A check for uneven wear, which can be an indication of chronic under-inflation or overinflation, improper wheel alignment or tire balancing, or a problem with the suspension system.
- A check for imbedded stones, glass or other foreign objects that could work into the tread and cause a leak.

Checking Tire Pressure

Check tire pressure when the tires are "cold" – in other words, when the vehicle has been stationary for at least three hours or has not been driven more than two kilometres. Note any tire that is under-inflated and then drive to the nearest refuelling station that has an air pump. If you have driven more than two kilometres, check the tire pressure again. Using the following example, inflate the tire to the correct pressure:

a) If the correct pressure is 35 psi (241 kPa), and three tires are at that pressure but one is at 28 psi (193 kPa), this tire is 7 psi (48 kPa) under-inflated (20 percent under-inflation, which means four percent excess fuel consumption).

b) Assuming you drove eight kilometres to find a fuel station with an air pump, all of your tires will have warmed up. When you check the tire pressures again, you might find that the three correct ones are now at 37 psi (255 kPa), and the under-inflated tire is at 30 psi (207 kPa). The low tire is still 7 psi (48 kPa) under-inflated, and the others are not overinflated.

c) Inflate the low tire to 37 psi (255 kPa). It's all right to exceed the normal recommended pressure, because the tire is no longer cold and warm tires gain pressure (tire manufacturers allow for this in tire design). The three tires that were correctly inflated when cold should not be adjusted.

d) It's advisable to purchase your own tire pressure gauge because those at air pumps are often inaccurate or missing.

It's also a good idea to rotate your tires regularly to distribute the wear evenly between all four tires. In addition to promoting long tire life, this will help your tires deliver the best possible economy and safety. The recommended rotation pattern for your vehicle is shown in the owner's manual. The general practice is to rotate tires every 10,000 km, which is twice a year for most drivers.

Tires are not all created equally. Bias-belted tires are stiffer than radial tires and have a higher rolling resistance, which makes the engine work harder to move the car down the road. If you need to replace a tire or tires, consult your owner's manual or a tire professional for information on the right type and size for your vehicle.

From an energy efficiency point of view, the most desirable attributes of a replacement tire are low rolling resistance and long tire life. Most tire professionals are aware of the importance of rolling resistance and can discuss tire choices accordingly. Generally, a 10 percent reduction in rolling resistance will result in a two percent reduction in fuel consumption.

For the best performance, ask a tire professional to help you choose quality tires with a low rolling resistance and a long projected tread life that will meet your vehicle and driving needs.

Wheel Alignment and Balancing

Wheel alignment should be checked once a year. If the tires are misaligned, they will drag instead of roll freely. This will increase fuel consumption, reduce tire life and cause problems with the vehicle's handling and ride.

Wheels should also be balanced. If they are out of balance, the driver will feel a pounding or shaking through the steering wheel. This pounding will shorten the life of other suspension components and will produce uneven tire wear, which will increase fuel consumption. Tires that are not balanced exhibit "cupping," a wear pattern that looks like a series of bald spots.

Exhaust System

Leaks and malfunctions in the exhaust system are not only noisy, they're dangerous to you and harmful to the environment.

A damaged or faulty exhaust system can leak deadly carbon monoxide fumes into the passenger compartment. It can also upset the balance of pressure in the engine-exhaust system, reducing your engine's operating efficiency and increasing fuel consumption. To be safe, have the exhaust system checked at the interval specified in the owner's manual.

Air and Fuel Systems

Air for the engine passes through the air filter, whose job it is to remove dust and dirt that could damage the engine. A clogged filter will restrict airflow, causing reduced performance, increased fuel consumption by as much as 10 percent and higher emissions. The air filter should be inspected every year and replaced when required (on average every 48,000 km).

A dirty air filter reduces performance and can increase fuel consumption.

Similarly, fuel passes through a filter on its way from the tank to the engine. A clogged fuel filter will restrict fuel flow, causing driving problems and increased exhaust emissions. The recommended replacement interval for fuel filters varies widely, from every 24,000 km to "only as required," so check your owner's manual.

You should also follow the manufacturer's instructions for having the fuel lines, tank and cap inspected for damage and leaks. A leaking fuel system is dangerous and increases fuel consumption and evaporative emissions (emissions released into the atmosphere when fuel evaporates).

Perform a Monthly Check

As we've already suggested, most maintenance should be left to the professionals. However, once a month you should perform the following checks to help identify and head off problems that can cost you fuel and money down the road:

- Check tire pressure and look for signs of uneven wear or embedded objects that can cause air leaks. In winter, check tire pressure whenever there is a sharp change in temperature.
- Check around the car and under the engine for fluid leaks. You can often identify the type of fluid that is leaking by its colour. Oil is black, coolant is a bright greeny yellow, automatic transmission fluid is pink, and power steering and break fluid are clear, with a slight brown tinge. All of these fluids are oily to the touch.
- Check fluid levels, including engine oil, engine coolant level, transmission fluid and power steering fluid, according to the instructions in the owner's manual.
- Check under the hood for cracked or split spark plug wires, cracked radiator hoses or loose clamps and corrosion around the battery terminals.
- Check for problems with the brakes. On a straight, flat and traffic-free stretch of road, rest your hands lightly on the steering wheel and apply the brakes gradually. If the vehicle swerves to one side, one of the brake linings may be worn more than the other, or the brakes may need adjustment.
- Use a similar test to check for problems with wheel alignment. On a straight, flat and traffic-free stretch of road, rest your hands lightly on the steering wheel and drive at an even speed. If the vehicle pulls to one side, the wheels may be misaligned.

Section 6

Alternatives to Gasoline

QUICK READ

1. Depending on where in Canada you live, you may have access to transportation fuels other than gasoline and regular diesel fuel. Several alternative fuels are available that can save you money and reduce emissions.
2. Gasohol – fuel blends of five to 10 percent ethanol mixed with gasoline – are now sold at many fuelling stations in Canada. These low-level ethanol-gasoline blends are compatible with most gasoline engines without voiding the manufacturer's warranty, and can reduce greenhouse gas emissions from your vehicle.
3. Automakers currently produce a number of vehicles that can run on E85, an ethanol-gasoline mixture that can be up to 85 percent ethanol.
4. Natural gas and propane are the most common alternative fuels used in Canada. They both offer many environmental benefits and are cheaper than gasoline, so the extra cost of converting an existing gasoline vehicle or purchasing a new factory-produced natural gas or propane vehicle can often be recovered in a few years through fuel savings.
5. All of the major automakers are developing zero-emission electric vehicles. One of the most promising technologies is the hybrid electric vehicle, which uses a combination of high-power electric batteries and an internal combustion engine.
6. The hydrogen fuel cell is another promising transportation energy technology.

The two most common transportation fuels in Canada today are gasoline and diesel fuel. Gasoline is by far the most widely used fuel in cars, light-duty trucks and some buses; diesel fuel is popular in larger vehicles.

However, depending on where you live, you may have access to other transportation fuels that can save you money and reduce emissions. This section provides additional information on some of your fuel alternatives. The Natural Resources Canada Web site at **vehiclefuels.gc.ca** provides information on the availability of some of these fuels in different regions of Canada.

Ethanol-Gasoline Blends

Ethanol is a liquid fuel that can be produced from corn, agricultural and forestry wastes or natural gas. Since crops and trees remove carbon dioxide (CO_2)from the air as they grow, the blending of biomass-derived ethanol with gasoline can result in a net reduction in CO_2 emissions.

Low-level blends of five to 10 percent ethanol mixed with gasoline – often called gasohol – are now sold at many fuelling stations in Canada. These blends are compatible with most gasoline engines without voiding the manufacturer's warranty. However, check the owner's manual before using ethanol-blended gasoline.

When purchasing ethanol-blended gasoline, look for the "EcoLogo" label. This indicates that the ethanol portion of the fuel has been derived from biomass sources and the fuel meets certain government standards limiting its volatility (evaporative ability).

In relation to gasoline, low-level ethanol blends offer a number of environmental benefits. These include a reduction of about 4 % in greenhouse gas emissions (if Ecologo fuel is used) and a slight reduction in other toxic emissions.

Ethanol-gasoline blends offer environmental benefits in the form of reduced emissions of greenhouse gases and toxic compounds.

Some North American automakers are now manufacturing E85 vehicles, which can run on a fuel mixture of gasoline and up to 85 percent ethanol. As noted earlier, E85 is not widely available as a transportation fuel, so these vehicles are designed to operate on straight gasoline or any blend of gasoline and E85. For motorists, E85 is not currently a viable fuel due to lack of refuelling facilities.

Low-Sulphur Diesel Fuel

Diesel fuel typically contains more sulphur than gasoline, which means that significant amounts of sulphur dioxide and sulphur particulates are produced during combustion. These sulphur compounds react with water vapour in the atmosphere, forming sulphuric acid that falls as acid rain.

The use of low-sulphur diesel fuel reduces these sulphur-related emissions – in fact, engines built in the 1995 model year and later must use low-sulphur diesel fuel in order to retain their emissions certification and warranty. Low-sulphur diesel fuel can also be used in engines built before the 1995 model year to reduce sulphur emissions and improve air quality.

Biodiesel

Biodiesel is an alternative fuel made from the oils and fats of plants, such as soybean or canola. Because it is a biomass-based fuel, it contributes no net CO_2 or sulphur to the atmosphere and is low in particulate emissions. Biodiesel is a renewable fuel that can be used in diesel vehicles with no engine modifications, without noticeable loss of power or torque.

Biodiesel is not yet widely available in North America. However, research is under way to reduce the cost of production.

Natural Gas for Vehicles

Natural gas for vehicles is the same fuel that is used to heat homes. It offers both economic and environmental benefits as a transportation fuel. The average price of natural gas can be as much as 40 percent cheaper than gasoline, and natural gas produces fewer emissions of CO_2, carbon monoxide, oxides of nitrogen and toxic compounds, as well as negligible evaporative emissions. Natural gas has up to 60 percent less potential to form ground-level ozone than gasoline.

To use natural gas as a transportation fuel, you can either convert existing gasoline vehicles or purchase factory-produced natural gas vehicles. Conversions of existing vehicles typically cost between $3,500 and $4,000 per vehicle (conversion kits exist for most vehicles produced in North America). New factory-warranted vehicles may cost significantly more than the same gasoline model. However, factory-produced natural gas vehicles are more efficient than conversions because the engine and other components have been properly matched to the fuel.

Most of the 30,000 natural gas vehicles in Canada today are converted bi-fuel vehicles, which means they can run on either natural gas or gasoline.

The cost involved in converting a vehicle to natural gas can be quickly recovered through reduced fuel costs.

Because natural gas is about 40 percent cheaper than gasoline, the extra cost of converting a vehicle or purchasing a new factory-produced natural gas vehicle can often be recovered in a few years through fuel savings. The payback will be quicker – and the ongoing savings more impressive – if the vehicle has a big engine, has high annual mileage or operates exclusively on natural gas. Engine maintenance costs should also be lower when natural gas is used.

Natural gas is stored and burned as a gaseous fuel, which means that high-pressure storage is needed to ensure that enough fuel is on board to provide a reasonable driving distance. Bi-fuel conversions often require that cargo or trunk space be used to hold fuel cylinders.

A full-sized car or minivan operating on natural gas has a range of 160 to 200 kilometres when two storage tanks are used. If longer distances between refuelling are required, the original gasoline system can be left in place, thus ensuring that the vehicle will be able to refuel anywhere gasoline is sold.

In 1999 there were approximately 130 public natural gas refuelling stations in Canada, concentrated in the lower mainland of British Columbia, in the Calgary–Edmonton corridor and in southern Ontario. Private on-site refuelling is also an option in all areas served by natural gas.

Propane for Vehicles

Propane is the most common alternative fuel used in Canada. It offers many of the same economic and environmental benefits as natural gas, including lower cost and reduced exhaust emissions.

As is the case with natural gas, propane is used as a transportation fuel either by converting existing gasoline vehicles or by purchasing a factory-produced propane vehicle. Conversions typically cost between $2,400 and $2,800 per vehicle (conversion kits exist for most vehicles produced in North America). Some North American vehicle manufacturers offer the propane option on a limited number of new vehicles, but they carry a substantial price premium over the same gasoline model. Almost all of the 150,000 propane-capable vehicles in Canada are converted vehicles, and many are bi-fuel (propane-gasoline).

Propane is on average 25 to 35 percent less expensive than gasoline in most parts of Canada, although it is subject to seasonal price swings. The extra cost of converting a vehicle or purchasing a new factory-produced propane vehicle can be recovered through reduced fuel costs. The investment payback will be quicker if the vehicle has a high fuel-consumption rate, has high annual mileage or operates exclusively on propane. Spark plug and oil maintenance costs are also usually lower with propane than with gasoline.

Propane offers significant fuel-cost savings and is widely available at public refuelling stations.

Propane is a gaseous fuel that is compressed into a liquid and stored in low-pressure cylinders. This may require the use of cargo or trunk space to hold fuel cylinders.

Converted propane vehicles typically have an operating range of 400 kilometres (with an 80-litre tank). More range is available by installing additional storage tanks. Most conversions retain the bi-fuel capability to ensure that the vehicle's range is not limited. Propane refuelling is widely available at public stations throughout Canada.

Electric Vehicles

Electricity is the most available "fuel" in Canada. It offers two important benefits compared to gasoline: a significantly lower cost and zero emissions from the vehicle. Even allowing for emissions from electricity generating plants, the widespread use of electric vehicles would have a beneficial impact on air quality in major Canadian urban centres.

Electric vehicles are not widely available in Canada, but that may change in the not-too-distant future. Some automakers are offering electric vehicles for sale or lease in some parts of the U.S. Although these vehicles tend to be expensive and have a limited operating range, the involvement of the major automakers in the electric vehicle market is a positive sign.

Hybrid Electric Vehicles

One of the most promising new technologies is the hybrid electric vehicle, or HEV. HEVs have two onboard power sources, one of which is an electric motor driven by high-power batteries. The electric motor reduces the demand placed on the primary power source, which is usually an internal combustion engine running on gasoline or diesel fuel (although alternative fuels may also be used).

HEVs have several advantages over traditional internal combustion engine vehicles. From a climate change perspective, they offer greatly improved fuel economy (by as much as 40 to 50 percent compared to a conventional vehicle of the same size) and reduced greenhouse gas emissions. The potential to use alternative fuels in the internal combustion engine can further reduce emissions.

Both domestic and foreign automobile manufacturers have developed HEVs to meet the growing demand for cleaner, more efficient vehicles. HEVs became commercially available in Canada in the 2000 model year.

Hydrogen

Another of Canada's and the world's most promising transportation energy technologies is the hydrogen fuel cell. As is the case with battery-operated electric vehicles, all of the major automobiles manufacturers now have fuel cell programs. Several prototype automobiles and transit buses powered by hydrogen fuel cell engines are now in operation.

Hydrogen is the cleanest fuel in the world. Fuel cell powered vehicles using hydrogen on board produce no greenhouse gas emissions, no particulates or hydrocarbons, no carbon monoxide, no nitrogen oxide or ozone, and no toxic components – in other words, they are zero-emission vehicles! However, depending on the fuel source, production of the required hydrogen can generate some emissions.

Studies have shown that a hydrogen fuel cell vehicle is two to three times more energy efficient than an internal combustion engine running on gasoline or diesel. However, a major obstacle to the use of hydrogen as a fuel is the lack of hydrogen infrastructure. Research is ongoing to make electrolytic hydrogen fuel available privately or at public service stations.

What's Next?

Now that you're an Auto$mart driver, what's next?

The first thing you should do is apply your knowledge on the road. The sooner you start, the sooner you will enjoy the benefits of fuel cost savings and a cleaner environment. And don't hesitate to share your Auto$mart knowledge with family, neighbours and friends. Encourage them to call 1 800 387-2000 to get their own copy of *The Auto$mart Guide* and other free publications on fuel efficiency such as the *Fuel Consumption Guide* and the *Fuel Consumption Calculator*.

It's also a good idea to keep up to date on fuel efficiency and alternative fuel developments. We encourage you to visit the Auto$mart Web site at **vehicles.gc.ca** for regular updates and new information, such as the latest fuel consumption ratings for new vehicles and the winners of the annual EnerGuide Awards for fuel-efficient vehicles in different categories. We can also help you find a driver training school that teaches Auto$mart techniques. Information on alternative fuels can be found at **vehiclefuels.gc.ca**.

The Canadian Automobile Association is another good source of information on fuel efficiency and other automotive matters. Visit the CAA's Web site at **http://www.caa.ca** or write to:

Canadian Automobile Association
1145 Hunt Club Road
Suite 200
Ottawa ON K1V 0Y3

When writing to the CAA for information, include a self-addressed, stamped, business-size envelope for return mail.

Being fuel efficient on the road is not the only way to save money and help the environment. For information on the many ways you can reduce your energy consumption at home and at work, visit the Office of Energy Efficiency's Web site at **http://oee.nrcan.gc.ca** or call our publications line at 1 800 387-2000. We have a wealth of information for Canadian consumers, homeowners, fleet operators and businesses – and it's all free!

Section 8

Glossary of Automotive Terms

Accelerator	The driver-operated pedal used to control engine speed.
Additive	A chemical that is added, in relatively small amounts, to gasoline or oil with the objective of enhancing performance.
Air filter	The air filter removes dust and dirt from the air being fed into the engine.
Alignment	The process of positioning wheels into a correct relationship with each other and with the steering/suspension system.
All-wheel drive	A drivetrain configuration in which all four wheels are driven by the engine.
Alternator	A device that converts mechanical power from the engine into electricity for certain vehicle components.
Antifreeze	A chemical solution that lowers the freezing point and raises the boiling point of the engine coolant.
Automatic transmission	A transmission configuration in which the vehicle moves from one forward gear to another automatically (i.e., without manual shifting of the gears).
Brakes	See disc brakes, drum brakes, hydraulic brake, power brakes.
Brake fade	The vehicle takes longer to stop the second or third time brakes are applied due to buildup of heat in friction surfaces.
Brake fluid	A hydroscopic liquid (absorbs water) with a high boiling point, used in a hydraulic brake system.
Brake pads	In disc brakes, the pads are held by a caliper and squeezed against the disc to produce friction and slow the vehicle.
Brake shoes	In drum brakes, the shoes are pushed against the drum to produce friction and slow the vehicle.

Carbon monoxide	A colourless, odourless, deadly substance present in exhaust gases. The chemical symbol is CO.
Carburetor	A device that mixes air and fuel for burning in the engine's combustion chamber.
Catalytic converter	A component of the exhaust system that converts certain exhaust pollutants into harmless substances. Engines with catalytic converters must be run on unleaded gasoline.
Clutch	A coupling device used to engage or disengage the flow of power from one moving part to another, such as from an engine to a transmission.
Continuously variable transmission (CVT)	A form of automatic transmission that uses belts and pulleys instead of gear wheels to allow an infinite number of gears.
Coolant	The liquid used in the engine cooling system, usually a mixture of water and antifreeze.
Cylinder	A hole in the engine block in which a piston moves up and down and combustion occurs. Engines can have three to 12 cylinders.
Detonation	Rapid, uncontrolled fuel combustion in the combustion chamber, which can cause engine damage. Usually occurs in heavy load conditions, such as when a trailer is being pulled or the vehicle is climbing a hill. Sometimes audible and described as "knock" or "ping."
Diesel engine	An internal combustion engine that ignites fuel solely by means of the heat of highly compressed air within its cylinders.
Disc brakes	A braking system that employs a rotating steel disc and a caliper containing pads that pinch the disc to produce friction to slow the vehicle.
Distributor	An electrical switching device that controls the production and distribution of high-voltage charges to the spark plugs in the correct sequence.
Drum brakes	A brake system that uses a wheel cylinder to force two brake shoes against a rotating drum. (used primarily as rear brakes, but have been used in the front in older vehicles.
Engine block	The main part of an internal combustion engine, containing the cylinders.
Filter	A device that removes foreign particles from air or fluids (gas or oil).
Four-wheel drive	A drivetrain configuration in which two or all four wheels can be driven by the engine.
Front-wheel drive	A drivetrain configuration in which the front wheels are driven by the engine. This is the most common configuration in passenger cars and minivans today because it offers better traction and more interior room than rear-wheel drive.
Fuel injection	A fuel system that does not use a carburetor but instead sprays a specified amount of fuel into the intake manifold (cylinder for diesel engines) of an internal combustion engine. Electronic fuel injection means the amount of fuel is controlled by on-board electronics.

Fuel pump	A mechanical or electrical device that moves fuel from the fuel tank into the carburetor or fuel injection system.
Hydraulic brake	A brake that is activated by fluid moving under pressure. Most automobile brakes employ this method.
Hydrocarbon	A chemical compound of hydrogen and carbon. All petroleum fuels are composed of hydrocarbons.
Ignition system	The system that produces and distributes the electrical spark to ignite the fuel mixture in the cylinders of a gasoline engine.
Manual transmission	A transmission configuration in which the driver is required to manually shift gears.
Multi-viscosity oils	Engine oils that have flow characteristics that ensure adequate lubrication at both high and low temperatures.
Oil filter	A replaceable filter element that removes foreign particles from oil.
On-board diagnostics	A system that monitors emission-related components and alerts the driver to problems by illuminating the "Check Engine" or "Service Engine Soon" indicator light.
Overdrive	A gear ratio designed for most transmissions that allows the driveshaft to turn faster than the crankshaft, resulting in higher road speeds with less engine effort and fuel consumption.
Piston	The component that moves up and down in the engine cylinder.
Power brakes	A brake system that uses assistance (usually from a vacuum) to augment the force applied by the driver.
Power steering	A system that uses a hydraulic pressure booster to augment the steering force applied by the driver.
Pre-ignition	The undesirable ignition of the air-fuel mixture before the spark is introduced. This can lead to detonation.
Radial tire	A type of tire in which the cords of the body plies run at right angles (radially) to the tire's centre line.
Radiator	The component of the cooling system that dissipates excess engine heat into the air.
Rear-wheel drive	A drivetrain configuration in which the rear wheels are driven by the engine.
Re-refined motor oil	Engine oil recovered from oil changes that is then taken to a recycling plant and rejuvenated. The necessary detergents and additives are replaced in the oil, and impurities are removed.
Spark	A high-voltage electrical discharge that occurs when current that is moving through the spark plug jumps across the gap between two metal electrodes (see spark plug).
Spark plug	A porcelain-insulated metal device that conducts high-voltage electricity across a gap between two electrodes to ignite the fuel mixture.

Supercharger	A mechanically driven air compressor that increases the amount of air-fuel mixture supplied to the intake manifold to increase engine power.
Suspension	The system of springs, arms, shock absorbers and related components that connect a car's body and frame to its wheels and axles.
Synthetic motor oil	A type of motor oil that is manufactured, rather than refined from crude oil. Synthetic oil is formulated to have extremely good flow characteristics and resistance to viscosity breakdown.
Tachometer	An instrument used to measure engine speed in revolutions per minute (rpm). It can be used to support proper shifting of a manual transmission.
Timing	Regulation of the spark so that the air-fuel mixture is ignited at the right time.
Tire rotation	The process of systematically switching tires to different wheels on the vehicle in order to equalize wear and extend tire life.
Torque	A twisting or turning force measured in Newton-metres or foot-pounds.
Transmission	The system of gears, shafts and other components that multiplies engine torque and allows the engine to run at efficient speeds.
Tune-up	The process of checking, repairing and adjusting various components of the ignition and fuel systems to obtain maximum engine performance.
Turbocharger	An air compressor powered by exhaust gases. Its job is to increase the supply of air-fuel mixture to the intake manifold to increase engine power.
Two-wheel drive	A drivetrain configuration in which two of the vehicle's four wheels – either the front wheels or the back wheels – are driven by the engine.
Valve	A mechanical device designed to open and close in order to regulate the flow of fluid or gas.
Viscosity	The resistance to flow of a liquid, such as oil.

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